

OST
Ostschweizer
Fachhochschule

SPF Institute for Solar Technology, OST

Sorption activities

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INSTITUT FÜR
SOLARTECHNIK

Summary

- **SPF-OST Introduction**
- **Thermochemical storage**
 - Principle
 - Hybrid storage system
 - Test rig & Heat and mass exchanger optimisation
 - Ceramic 3D-pinted structures
- **Heat and mass exchangers characterisation for AdHP**
 - Test rig facility
 - Curent project and results

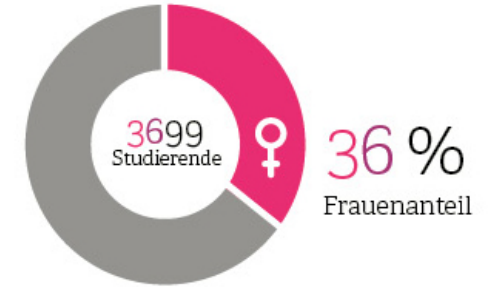
OST, University of applied sciences of eastern Switzerland



3
Campus:
Buchs, Rapperswil-Jona, St.Gallen



6
Departemente



22
Studiengänge
(Bachelor, Master)



180+
Hochschulkooperationen
in 52 Ländern

SPF – Institute for Solar Technology

- Institute of the Eastern Switzerland University of Applied Sciences
- Competence Center for Solar Energy since 1981
- 50 employees, 35 in aR+D
- 95% third party financed, 2.5 full-time equivalents in teaching



Heads of Institute and Teams:



A. Häberle
Head of Institute



S. Brunold
Vice Head of Institute
Collector technology /
Optics



A. Bohren
Head of Testing /
Monitoring



M. Haller
Head of Research
Energy systems



D. Carbonell
Thermal Systems /
Modelling



C. Biba
Photovoltaics



P. Gantenbein
Thermodynamics



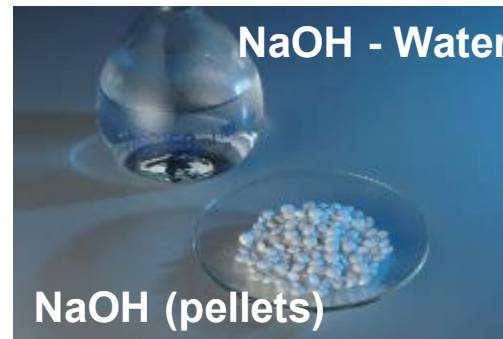
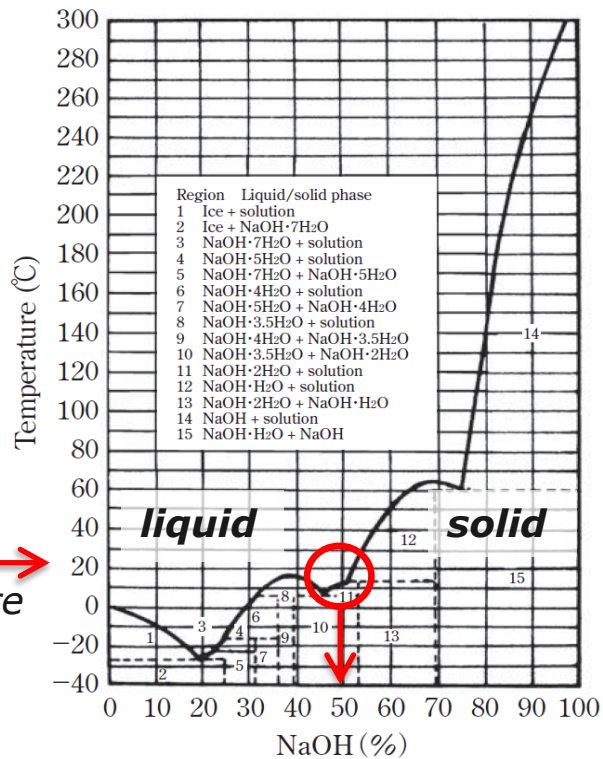
I. Bosshard
Energy efficient
buildings

Thermochemical storage

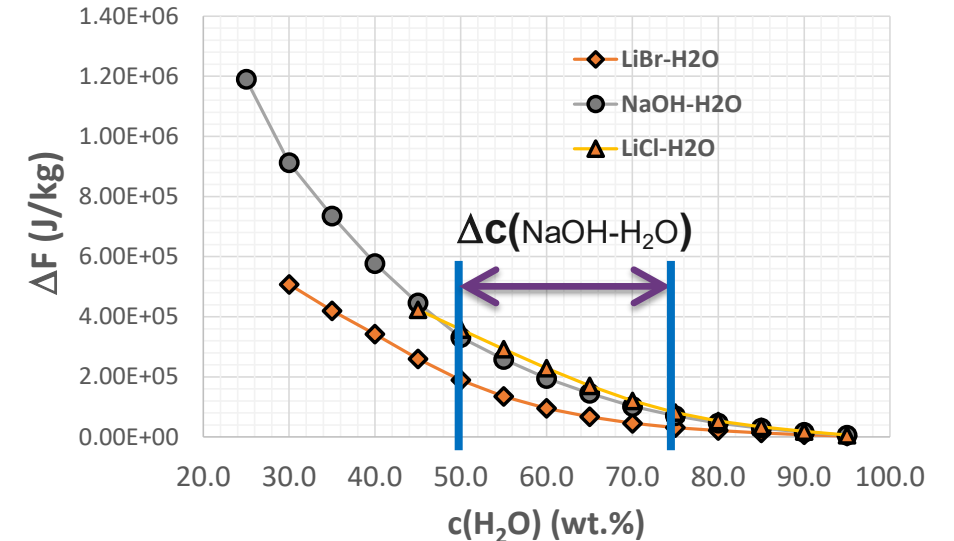
Principle – sorbent/sorbate combination



with l = liquid; v = vapour



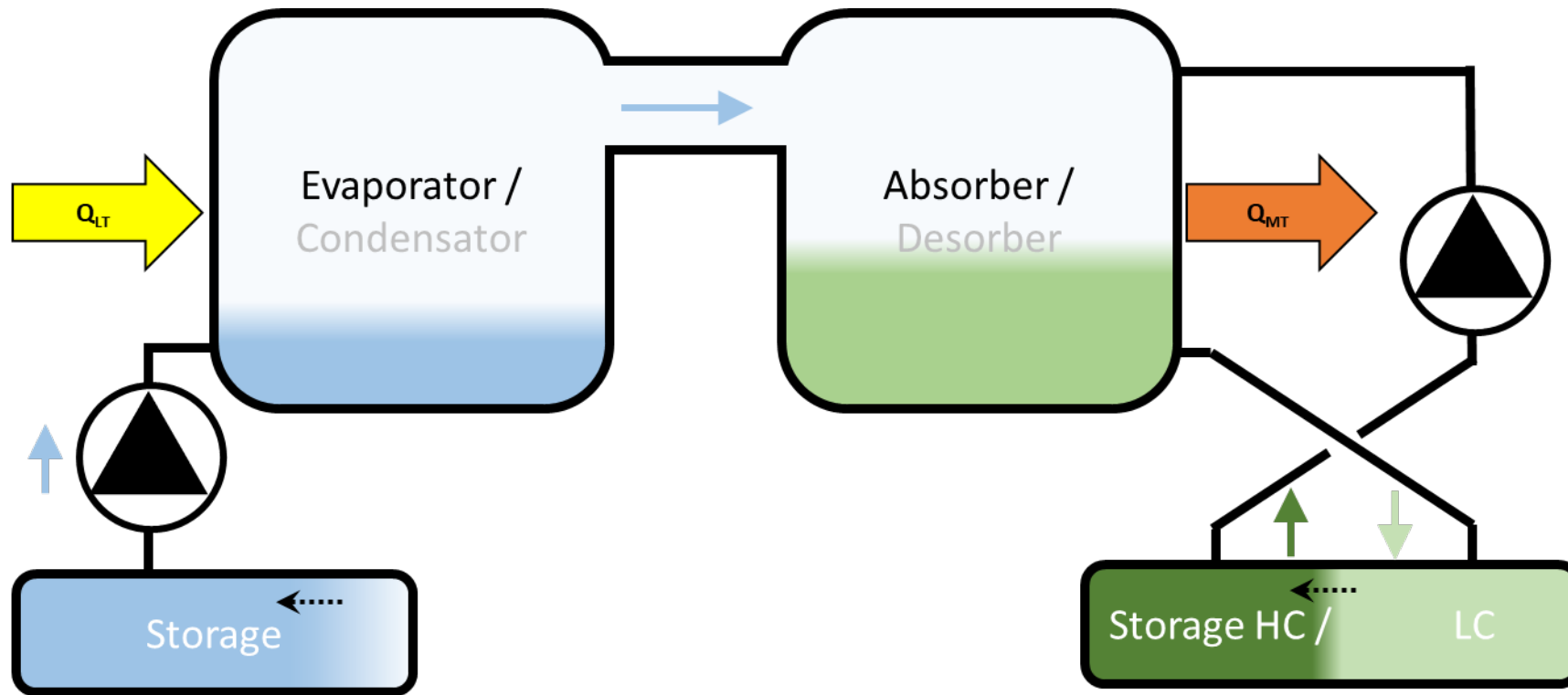
Absorption potential ΔF in function of load c



“heat of absorption”: vapour – liquid solution transition.
 example: at approx. 90 wt.% and higher water content the Δh_v of water vapour will be released.

SODIUM HYDROXIDE. CAS No: 1310-73-2, EINECS No: 215-185-5.
 Summary Risk Assessment Report. European Chemical Bureau I-21020 Ispra (VA) Italy.

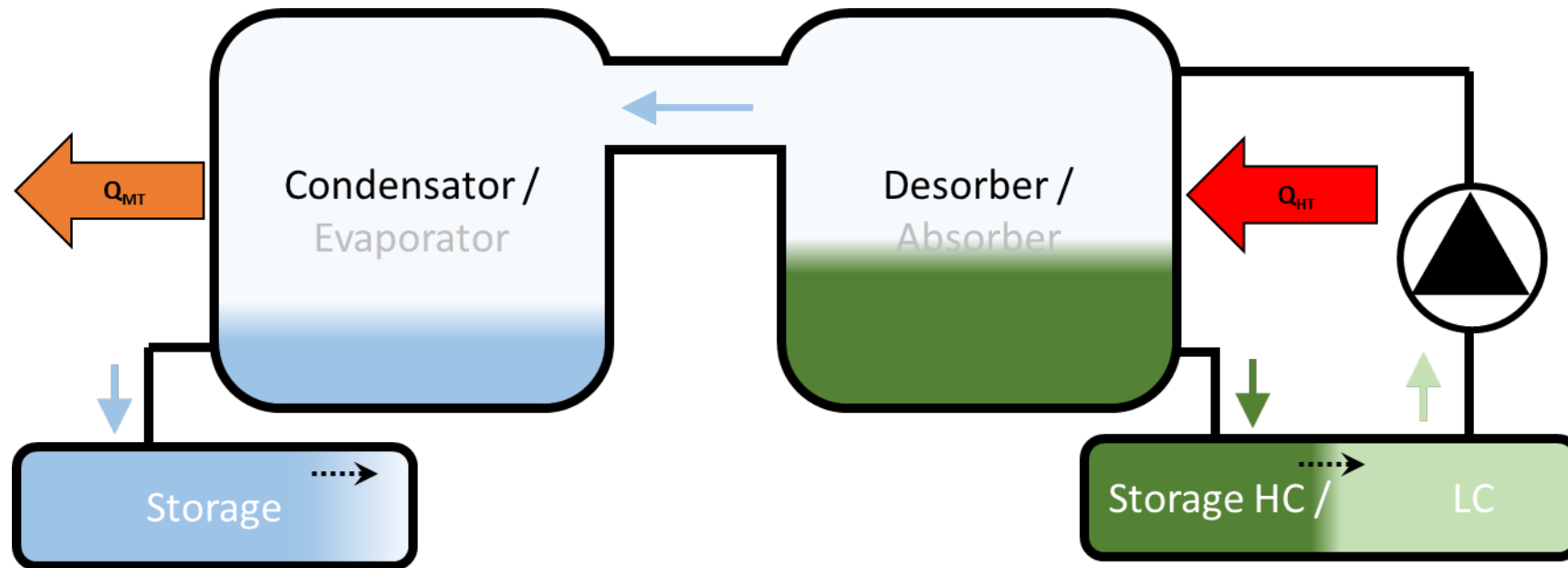
Principle - storage discharging mode



- Closed System – only heat transfer to the ambient
- Combined HME for absorption and desorption (timely/seasonally separated charging and discharging) + combined Tank

Thermochemical storage

Principle - storage charging mode



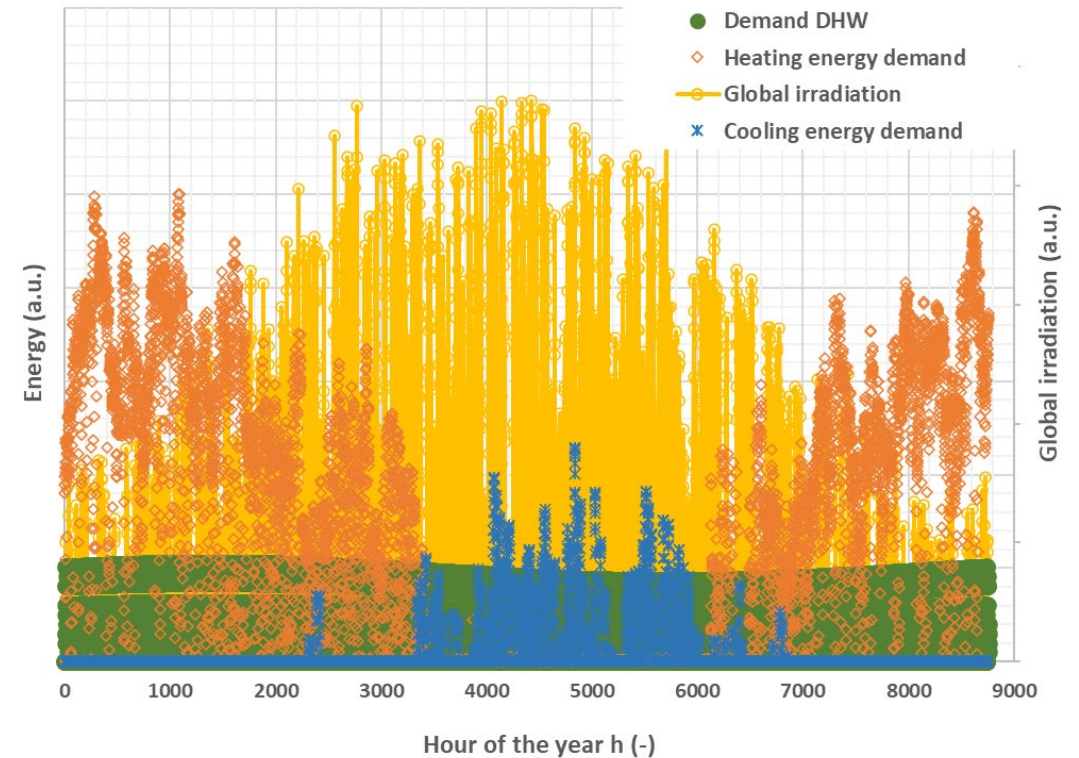
- De-coupling of power and capacity (A-D, E-C heat and mass exchanger vs. sorbent & sorbate tanks)
- Operation under sub-atmospheric pressure

Thermochemical storage

Hybrid storage system: energy and heating demand

EU BEST-Storage: building energy efficient system through short and long spectrum thermal energy storage

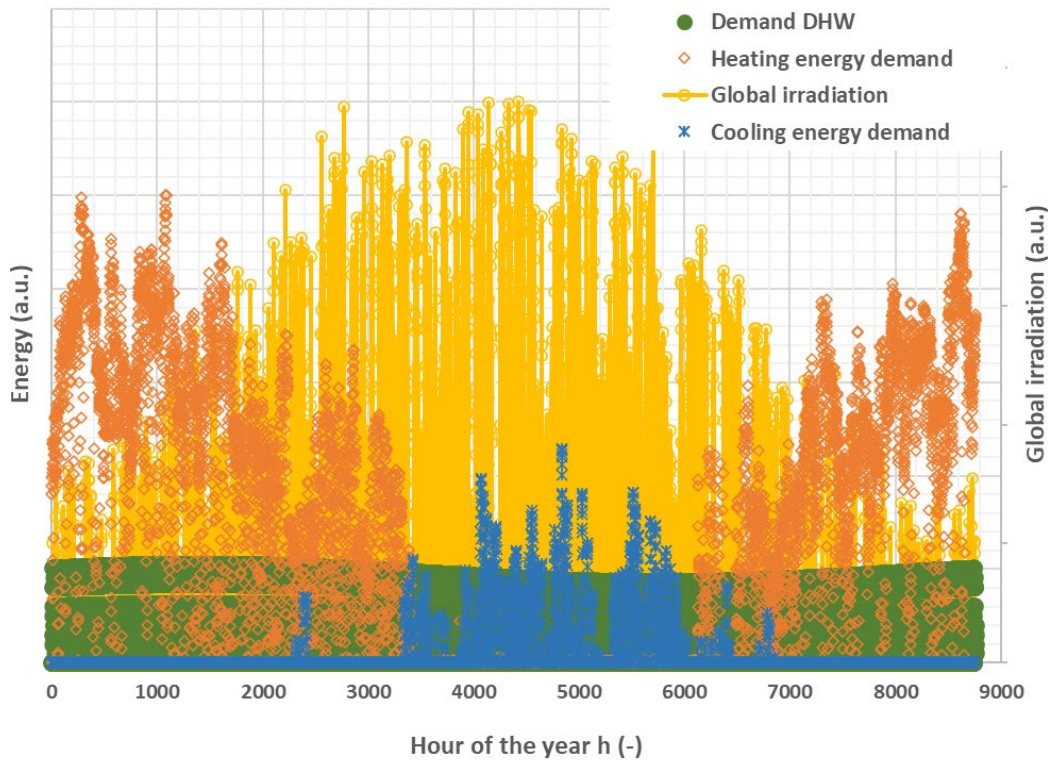
- WP3: Development of a modular Thermo-Chemical Energy Storage (TCS) system with heating emphasis
 - Within the 4-year project, two demonstrators planned (Thessaloniki & Tartu)



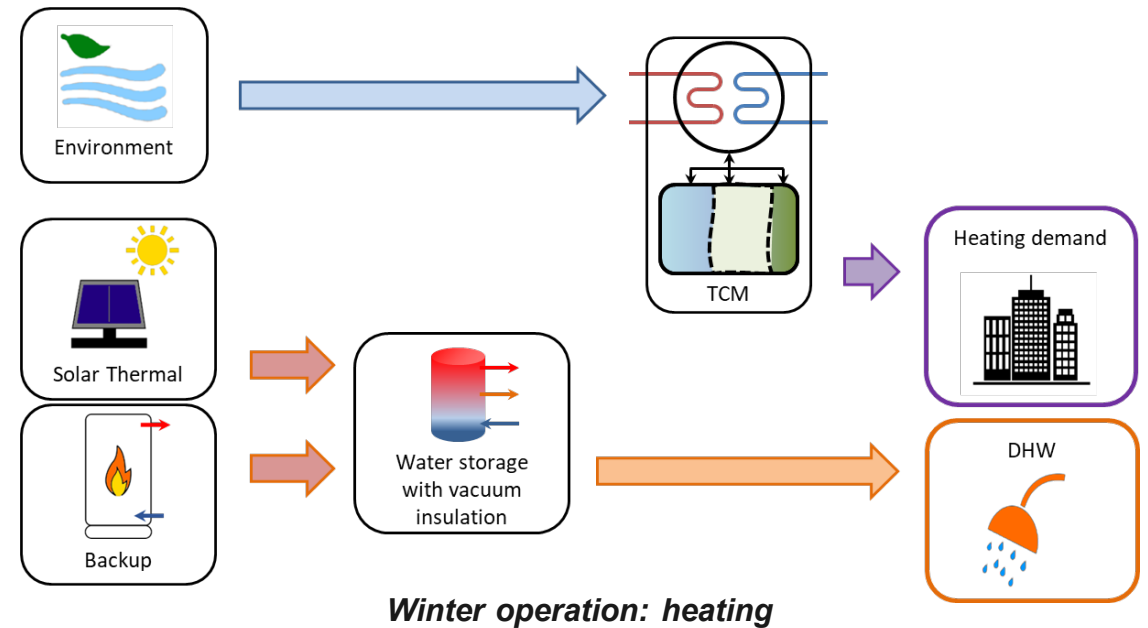
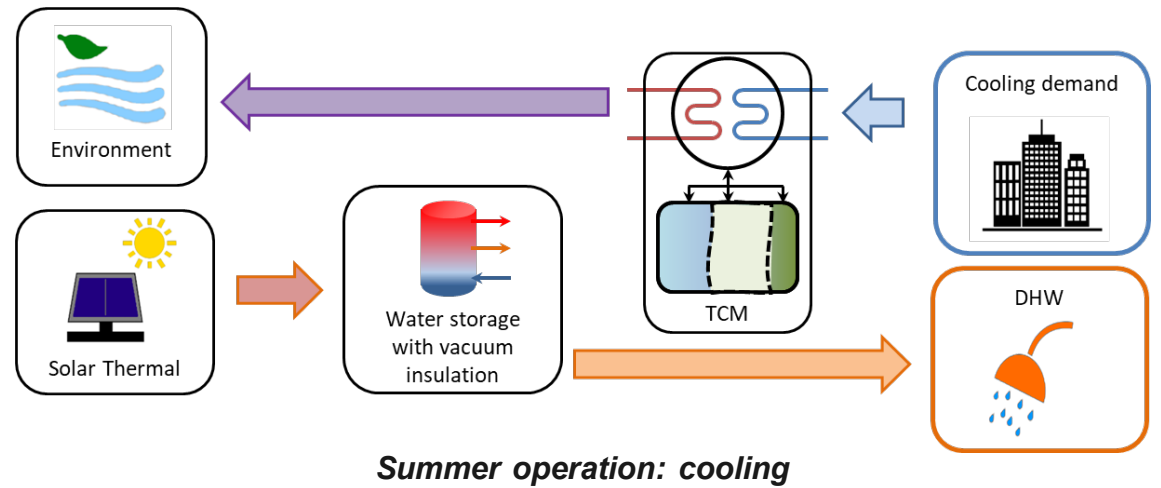
Heating-, cooling- & DHW-demand typical for a bigger building complex in Switzerland

Thermochemical storage

Hybrid storage system: discharging operation

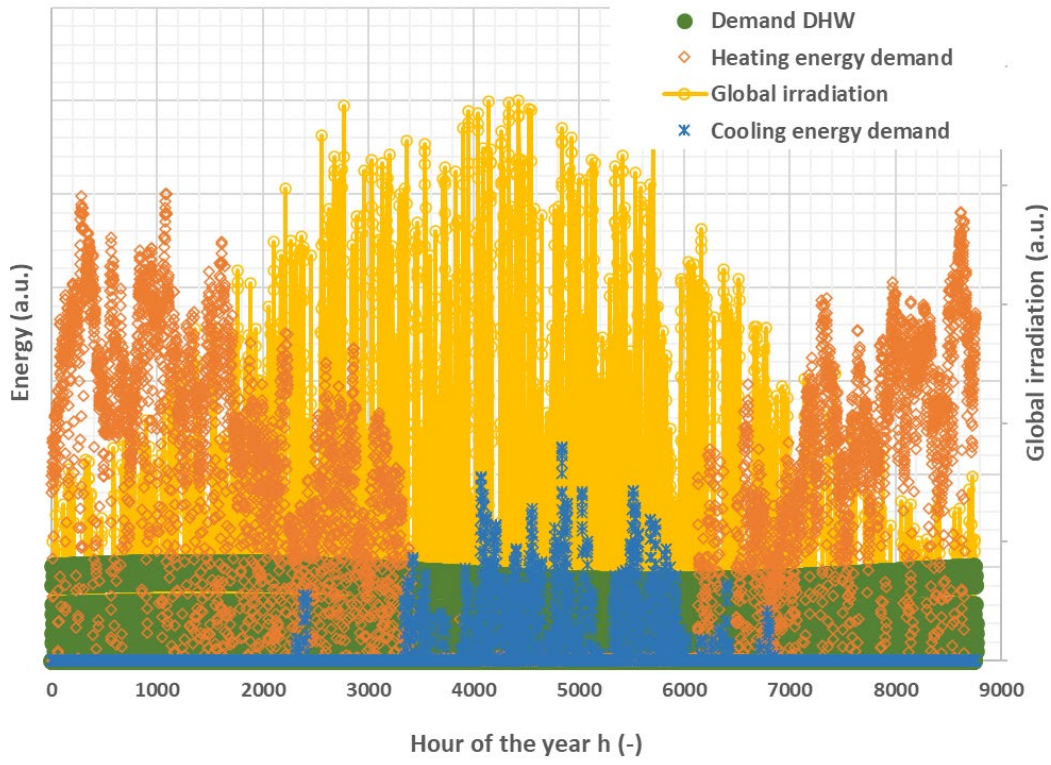


Heating-, cooling- & DHW-demand typical for a bigger building complex in Switzerland

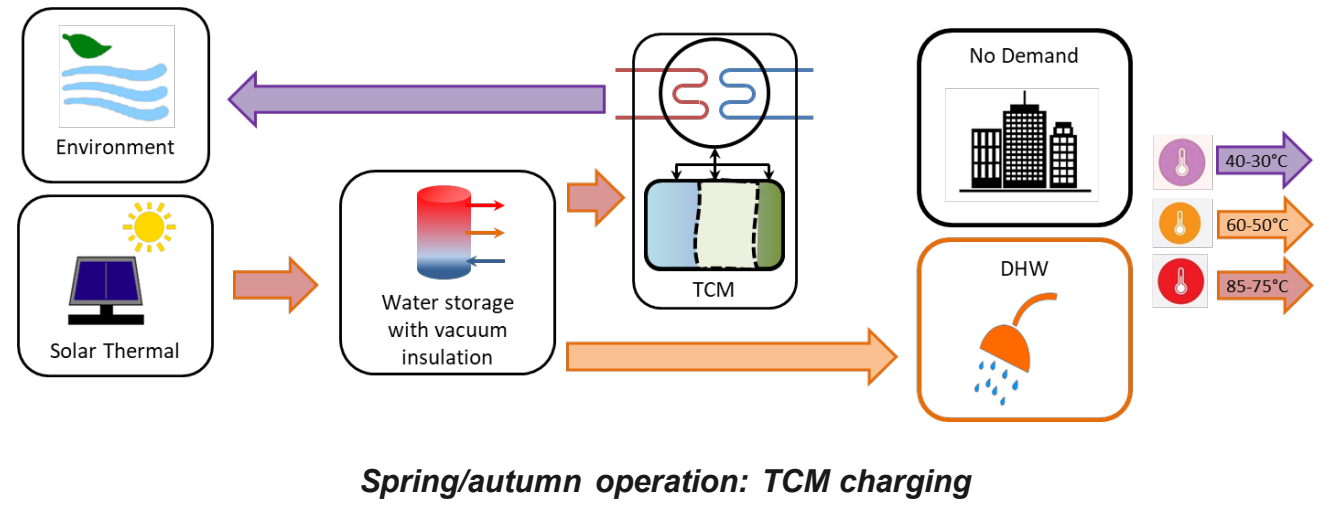


Thermochemical storage

Hybrid storage system: charging operation



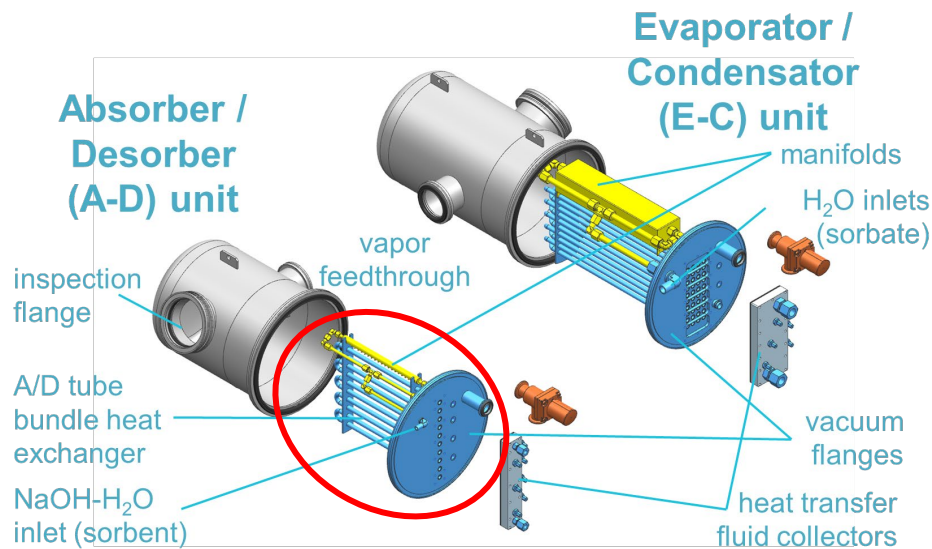
Heating-, cooling- & DHW-demand typical for a bigger building complex in Switzerland



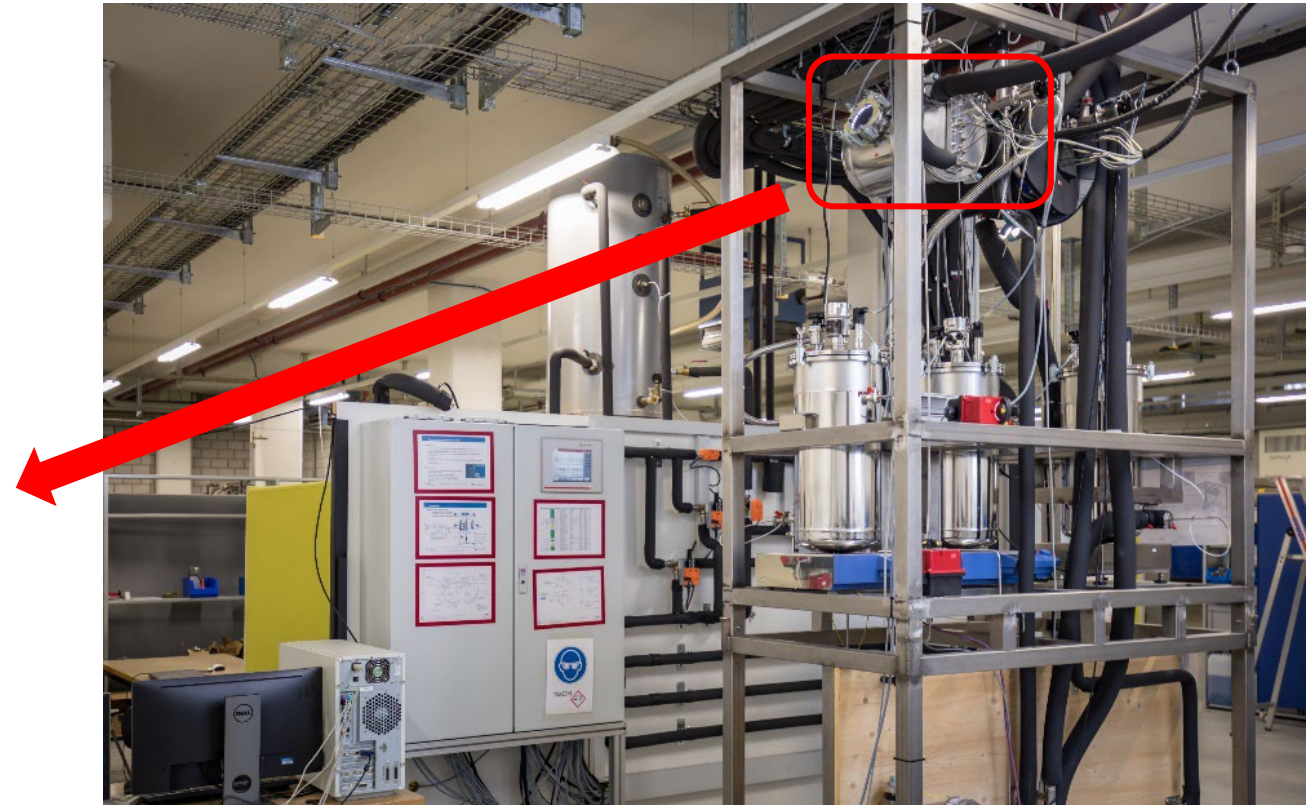
Heat and mass exchanger optimisation

Heat and mass exchangers characterisation

The 1 kW lab facility at SPF can be adapted to investigate the performances of the ceramic structures



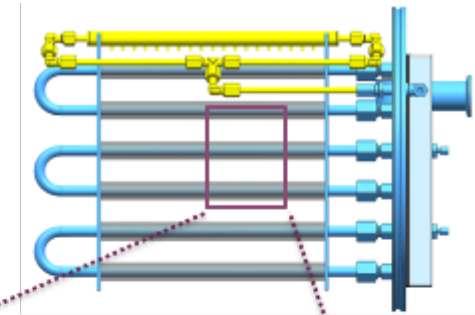
Dismountable A-D HME



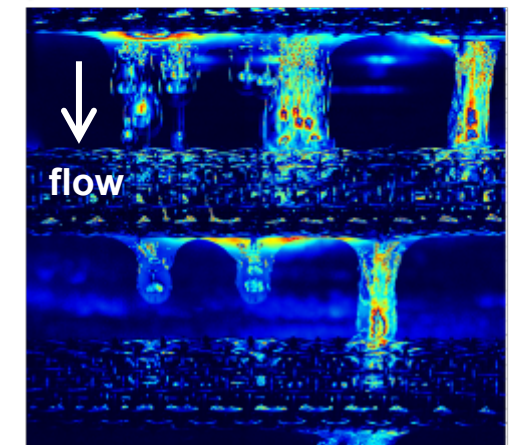
1 kW lab facility testrig

Power and Concentration Change

- **Characterisation of 5 falling film A/D HMX** were carried out in both absorption and desorption modus
 - => exchanged power, concentration difference as well as **heat and mass transfer coefficients and process efficiency** for each HMX are the main output.
 - => **Absorption Discharging: temperature lift $\Delta T (T_A - T_E) = 35 \text{ K}$ ($T_E 15 \text{ °C}$)**
- **Optical characterisation** opened the view to some HMX weakness and initiated the start to develop versions with optimised geometries
- **Encouraging results** obtained with the mesh wrapped tube geometry (up to **25 % more power** compared to the reference smooth tube geometry in absorption - discharging - mode)



A/D: six-tube mesh-HMX



Characterisation: Optical visualisation of tube surface wetting

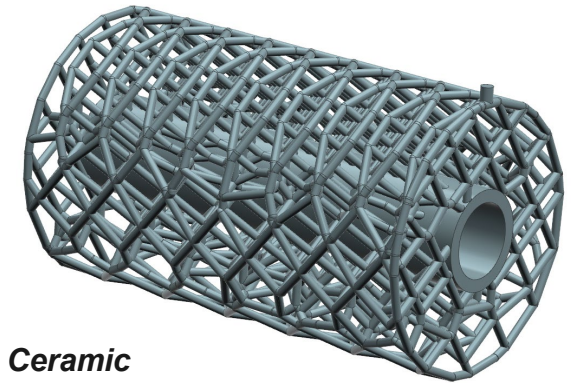
Heat and mass exchanger optimisation

Ceramic 3D-printed structures

Innosuisse HexCer: Heat and mass exchanger for absorption and desorption systems with engineered ceramic architectures produced by additive manufacturing

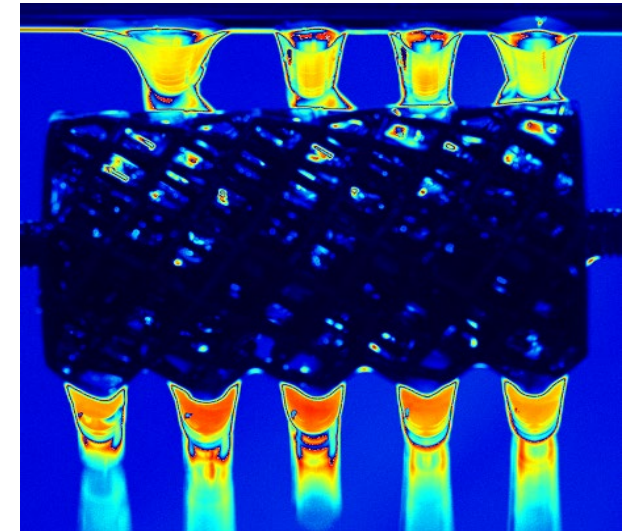
Bill of specification for the ceramic structures:

- high surface wetting of the HEX
- High transfer area (sodium hydroxide/vapour)
- Lye residence time in sorbate vapour
- fluid distribution/limited coalescence ("each foam acts as a manifold")



*Ceramic
foam structure*

SUPSI



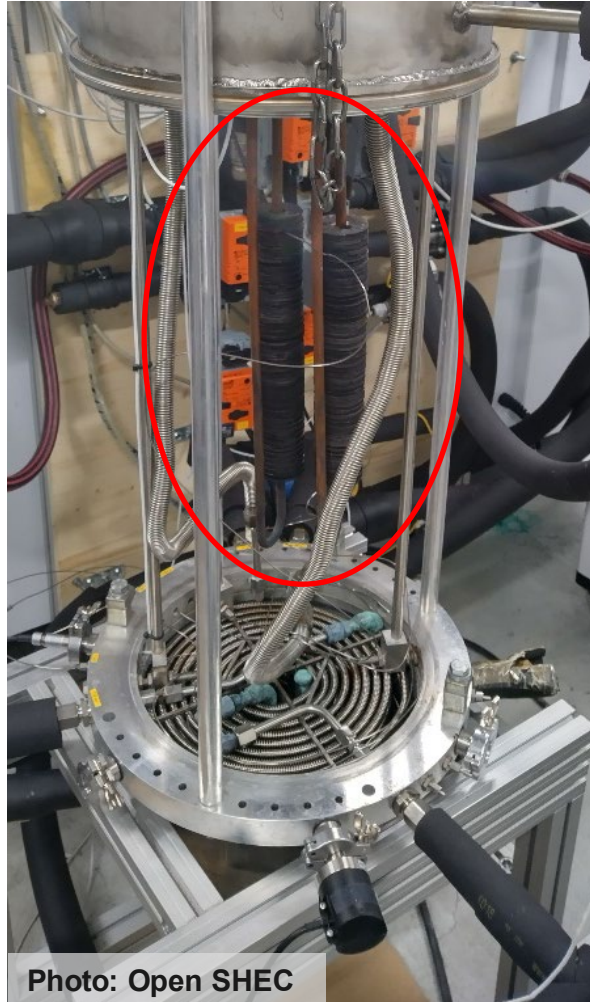
Structure Wetting & Flow Characterisation

Heat and mass exchangers characterisation for AdHP

Test rig facility

Single chamber lab facility:

- 1 kW of heat capacity
- Non-limiting combined Evaporator/Condenser (up to 5 kW)
- Weighting of the Adsorber/Desorber in real time

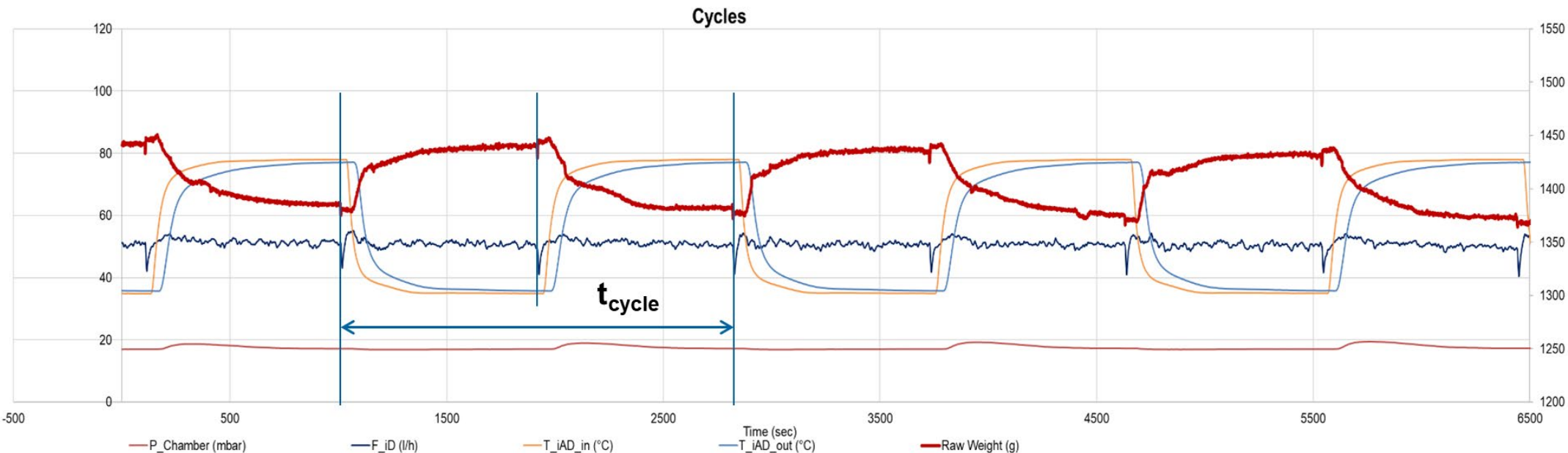
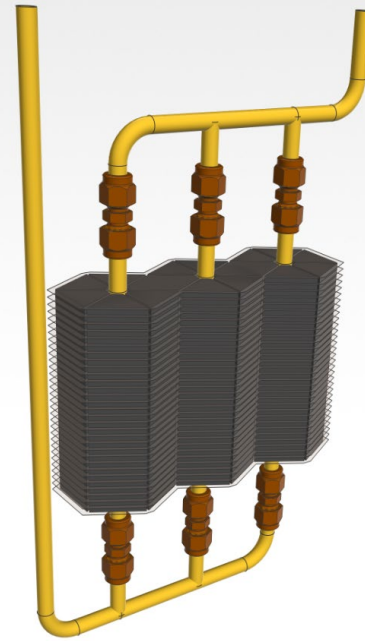


Heat and mass exchangers characterisation for AdHP

Curent project and results

SFOE CharacSorb: Optimized sorption heat pump for efficiency increase of district heating networks

Last generation of HME with carbon-monoliths

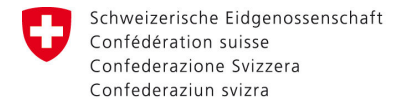


Typical Adsorber/Desorber characterisation

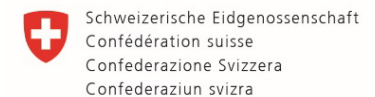
Many thanks for your attention!

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- Innosuisse HexCer – Swiss Innovation Agency



Swiss Federal Office of Energy SFOE



Swiss Confederation

Innosuisse – Swiss Innovation Agency